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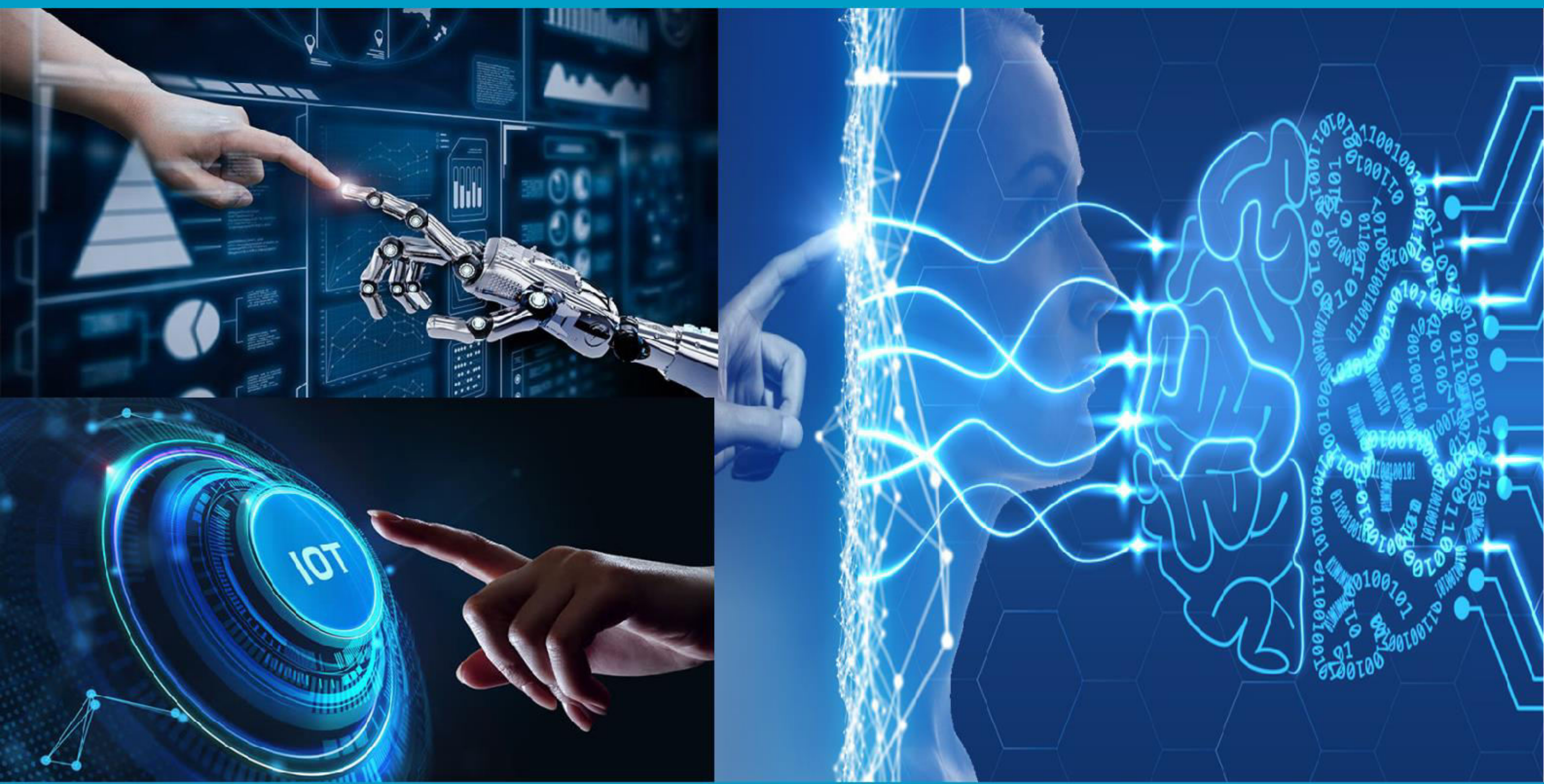

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Assessment of Occupational Health Risk in Stone Quarrying

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ABSTRACT: Occupational health is a neglected public health issue among stone quarry workers in developing countries. The quarrying sector poses large risks to their health and safety. Blood pressures (both systolic and diastolic), oxygen saturation (SaO_2), pulse rate and forced vital capacity (FVC) were measured on each participant. Body mass index (BMI) was calculated following the standard equation. Multivariate multiple regression (MMR) analysis was used to examine the effect of stone dust on the cardiovascular and pulmonary health of the workers. MMR results suggested that quarry workers revealed significantly ($p<0.0001$) lower systolic blood pressure (SBP), SaO^2 and FVC and a higher pulse rate ($p<0.0001$) than the control group. The study concluded that the exposure to stone dust among the quarry workers leads to deterioration of their cardiovascular and pulmonary health.

KEYWORDS-occupational, risk, health, workers, quarrying, stone

I.INTRODUCTION

Majority of the workers were in the age group 25-29 yrs [37.8%]. Most of the workers had injuries/cuts from stones 68.9%, respiratory symptoms [nasal discharge [52.3%], eye irritations 14.9%. A worker had traumatic amputation of Right thumb. PEF values of most (55.4%) of the workers were abnormal. Most workers are at serious risk of ill-health and injuries/accidents because of the conditions they encounter in their workplaces. All the quarry sites had no preventive/safety measures for the workforce; nor recreational lavatory facilities. There is urgent need on the part of the Federal Ministry of Solid Minerals to institute and enforce measures to prevent this menace. This requires a multi-disciplinary approach. Research into occupational hazards in stone quarry needs to be pursued vigorously. Physical work environment factors like noise and heat were also measured, and found to be above the acceptable levels. It is concluded that the working conditions in stone quarries, cutting and polishing units' needs to be improved. The postures adopted by workers are mostly in higher risk categories and need to be changed urgently. The noise levels are above the permissible limits and the use of PPEs should be encouraged. Overall the productivity of these industries can be improved by incorporating the ergonomics and OHS recommendations.[1,2,3]

Risk Assessment involve following five steps – Step 1: Identify the hazards Step 2: Decide who might be harmed and how Step 3: Evaluate the risks and decide on precautions Step 4: Record the findings and implement precautionary measures proposed Step 5: Review assessment and update if necessary

A quarry is a type of open-pit mine in which dimension stone, rock, construction aggregate, riprap, sand, gravel, or slate is excavated from the ground. The operation of quarries is regulated in some jurisdictions to manage their safety risks and reduce their environmental impact.[1][2]

The word quarry can also include the underground quarrying for stone, such as Bath stone.

Stone quarry is an outdated term for mining construction rocks (limestone, marble, granite, sandstone, etc.). There are open types (called quarries, or open-pit mines) and closed types (mines and caves).

For thousands of years, only hand tools had been used in quarries. In the eighteenth century, the use of drilling and blasting operations was mastered.[3]

The term remains used to describe a method of cutting into a certain shape, such as for glass and tile, as a "quarry cut".

The method of removal of stones from their natural bed by using different operations is called quarrying. Methods of quarrying include:

- a) Digging – This method is used when the quarry consists of small & soft pieces of stones.
- b) Heating – This method is used when the natural rock bed is horizontal and small in thickness.

- c) Wedging –This method is used when the hard rock consists of natural fissure. When natural fissures are absent then artificial fissures are prepared by drilling holes.
- d) Blasting – It is the process of removal of stones with the help of controlled explosives is filled in the holes of the stones. Line of least resistance plays very important role in the blasting process.

Following steps are used in the blasting process;[3,4,5]

- 1) Drilling holes – Blast holes are drilled by using drilling machines.
- 2) Charging – Explosive powders are fed into the cleaned & dried blast holes.
- 3) Tamping – The remaining portion of the blast holes are filled by clay, ash, fuse and wirings.
- 4) Firing –The fuses of blasting holes are fired by using electrical power supply or match sticks.

Hazard identification and risk assessment is a continual process. It is performed to identify whatever could cause injury, damage, ill-health, financial loss and loss of reputation to the organization. Hazard identification is an analysis to determine whether a risk agent under plausible conditions would cause harm to population or the environment. Hazard identification is an analysis which is in many ways involves a detailed study of various operations and processes, epidemiology, ergonomics. At mining, following operations could be the main hazards: a) Fall of sides b) Drilling operation c) Blasting operation d) Handling of Explosives e) Health Hazard f) Accident at site g) Transportation h) Natural hazards

a) Fall of Sides Fall of sides in a quarry can be a constant source of risk if the workings are not properly designed and if statutory provisions are not implemented in letter and spirit Overall slope angles of benches will be maintained at 45° Unmanageable heights are not created Loose sides are properly dressed Nature and structure of the rocks will be properly studied for their slips / faultlines No tree, loose stone or debris will be permitted to remain within 3 meters of the edge or side of any excavation (Regulation 106(4) of MMR 1961) No undercutting of any face or sides will be permitted so as to cause any overhanging (Regulation 106(5) of MMR 1961)[4,5,6]

b) Drilling Operation Drilling of holes for blasting is essential for excavation of hard rock. The main hazards associated with drilling are:- Dust generation during drilling operations Noise generation Entrapment of being stuck by a moving part of the drilling equipment

c) Dust generation during drilling operation The hazard is the inhalation of dust which is created during the drilling operation. Properly applied control measures can substantially reduce the risk to the drill operator Wet drilling is carried out by constantly injecting a jet of water at the drill bit inside the hole, which prevents dust generation In case due to any reason, wet drilling is not possible (due to non-availability of water), exhaust/ vacuum system is provided which removes the dust from the drill hole continuously and discharges the same in a dust collector specially provided for the purpose. Drilling machine shall be fitted with dust suppression, collection and disposal arrangement Deep wetting of drilling zones shall be done by water sprinkling before starting drilling. During drilling operations efforts shall be made to reduce dust generation by taking appropriate measures. The driller may fall over the edge of a working or abandoned bench, there is risk of boulders or materials falling onto workers at the foot of the face if proper precautions are not taken. Ensure that the equipment is suitable for the job and that the person in-charge of the drilling machine is competent to carry out the drilling operation. One of the measures that can be taken to reduce the risk of the edge of the bench is to provide suitable portable rail fencing which can be erected between the drilling operations and the edge of the bench. Attach a safety line to the drilling rig and provide a harness for the driller to wear.

d) Noise Generation Drilling operations give rise to harmful levels of noise. It is created by both drilling the hole and the operation of the drill rig itself. It is impractical to remove the hazard at the hole completely, but new generation drill rigs are quieter by virtue of its design The noise levels around drilling equipment should be measured and the risk assessed No-one, except driller and his assistant, should be allowed inside the designated drilling area The risk is highest with older machines. Newer large drilling machines are provided with sound insulated operating cabins which control the noise level within the cabins to acceptable levels. Other control measures include training operators and providing them with ear protection, although the later should only be seen as an interim precaution until a permanent solution can be found.[5,6,7]

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II.DISCUSSION

Entrapment of being stuck by a moving and revolving part of the drilling equipment There may be a number of hazards, principally those of moving the drilling rig around the site from one hole to another or from one working face to another The risk of an accident occurring will be low if the dangerous parts of the equipment are properly guarded, operators are well trained and supervised and only those essential to the work are involved in the activities. However, the risk of an accident will be high if the dangerous parts are exposed and the operators are poorly trained and supervised

c) Blasting Operation Most of the accidents from blasting occur due to the projectiles and mainly due to overcharging of the shot holes as a result of certain special features of the local ground. Flying rocks are encountered during initial and final blasting operations. Noise and dust also generated during blasting. Following control measures should be taken: Blast hole geometry shall be properly designed Blast site shall be wetted before and after blasting operations are completed Only optimum quantity of permissible explosives shall be used so that the vibrations do not damage the structures/houses if the quarrying operations are close to human habitation Blasting shall be conducted only during favorable weather conditions and only during the day time and permissible hours. While carrying out blasting operations near habitations, wide publicity will be given in the local area through announcement and other available media so that local people become aware of the blasting activities being undertaken in the area and take appropriate precautions The vibrations should be monitored periodically in consultation with the local Mining authorities.

d) Handling of Explosives Explosives by virtue of their nature have the potential for the most serious and catastrophic accidents in the mining industry yet the way they are used are an excellent example of how risk assessment is properly applied. For example only authorized and trained blaster (holding blasters certificate granted by DGMS) and his assistant will be allowed to handle explosives and carry out blasting operations. Use of explosives is specialized work. Planning for a round of shots is necessary to ensure that the face is properly surveyed, holes correctly drilled, direction logged, the weight of explosive suitable for good fragmentation and the continuity of the initiator are but a few of the steps necessary to ensure its safe use. Poorly designed shots can result in misfires, early ignition and flying rock. The storage of the explosives and its transfer to and from the quarry area shall be strictly in accordance with the conditions listed in the permission granted by Explosives Department. Few conditions are listed below: Proper and safe storage of explosives in approved and Licensed Magazine Proper security system to prevent theft/ pilferage, unauthorized entry into Magazine area and checking authorized persons to prevent carrying of match box, lights, mobile phones, cigarette or Bidi etc. will be put in place. Explosives shall be conveyed in special containers Explosives and detonators shall not be carried in the same container The holes which have been charged with explosives will not be left unattended till blasting is completed.[6,7,8]

e) Health hazards For the purpose of this document, health hazards should be interpreted as being harmful dust and noise which is emitted during surface mining operations. All suitable steps and precautions will be undertaken to ensure minimum health hazard. Use of Personal Protective Equipment (PPE) The PPE shall be of good make and quality, wherever possible ISI certified, suitable for the hazard e.g. a dust respirator fitted with the correct filter to capture the particular hazardous dust and maintained to recommended standards. As personal protective equipment only affords limited protection it should only be used as a last resort and as an interim arrangement until other steps are taken to reduce the risk of personal injury to an acceptable level.

f) Accident at Site Identifying the hazards that come along with the presence of vehicles at the workplace (e.g. reversing operations, loading) can cause harm if not properly handled. Among some of the factors that may make vehicle accidents more likely are: Rough access roads Time pressure Inadequate brakes (Possibly from lack of maintenance) Carelessly parked vehicles (e.g. being parked on a slope without being adequately secured) Untrained drivers Overturning vehicles To avoid such instances we will talk to the workers shall be trained and involve them in the risk assessment process and tell them what to do, to reduce risk.

g) Transportation The usual method of transporting minerals from the working face is by trucks / tippers/dumpers. Large earth moving equipments are used for loading /transporting large quantity of mineral from a mine. During transportation of minerals in the mining area, utmost care will be taken by the vehicle operator to avoid any accident with any incoming vehicle by keeping sufficient gap between the two vehicles, keep safe distance from the edge of the mine face, avoid any accident to a worker crossing the haul road and shall maintain low speed. The vehicle operator shall not try to overtake another vehicle. All transportation within the mine lease area should be carried out directly under the supervision and control of management. The vehicles will be maintained in good working condition and checked thoroughly at least once a month by the competent person authorized for the purpose by the management. Road signs will be provided at each and every turning point up to the main road (wherever required) To avoid danger while reversing the vehicles especially at working place/loading points, stopper should be posted to properly guide reversing/spotting operating. Only trained drivers will be hired. To prevent accidents during transportation in mine area, the mines roads Shall be made smooth by occasionally rolling with a road roller Shall be frequently cleaned of any stone /rock fallen from a plying dumper Shall be designed with suitable gradient well within the specifications prescribed under MMR 1961 Shall be designed sufficiently wide for two way traffic or separate routes for incoming and outgoing traffic shall be provided. Shall be kept suitably wetted to prevent dissipation of dust Shall have designated points for crossing by workers. Shall have suitable sign boards for information of the vehicle operator. Heavy Earth moving Machinery (HEMM) The operator/ transporter shall carry out regular maintenance of the machinery and vehicles as per manufacturer's guidelines. Operator's cabin of the HEMMs should preferably be air conditioned or at least air tight. The smoke emission should conform to the standards notified in Motor Vehicle Act. The trucks carrying the mined products shall be covered with tarpaulin so that there are no fugitive emissions during transportation. The transportation should not be through the busy roads in the city/towns/villages if by pass roads are available Overburden Dumps Stabilization Overburden dumps shall be suitably located and designed keeping in view the quantity of overburden to be stored as also the length of time for which the dump is to be there. A suitable retaining wall shall be provided around the dumps to prevent sediments from the dumps flowing downwards towards water body if any, or agriculture fields. Check dams (one or more, as per requirement) shall be constructed for further arrest of sediments from the dumps. Non-operative dumps shall be subjected to technical and biological reclamation. Plantation over and around over burden dumps shall be carried out to ensure stability of slopes, prevention of dust by wind action and soil erosion during the run off.

III.RESULTS

Exposure to dust due to stone quarrying can cause severe respiratory ailments. Besides lung problems, research shows that exposure to quarry dust may also increase the risk of health problems affecting the heart, liver, kidney, central nervous system, and other organs. Despite the fact that a lot of studies have been reported on the respiratory system, our aim was to explore the evidence on the association between occupational exposure to quarry dust and its effect on renal health.

Many quarry stones such as marble, granite, limestone, and sandstone are cut into larger slabs and removed from the quarry. The surfaces are polished and finished with varying degrees of sheen or luster. Polished slabs are often cut into tiles or countertops and installed in many kinds of residential and commercial properties. Natural stone quarried from the earth is often considered a luxury and tends to be a highly durable surface, thus highly desirable. Quarries in level areas with shallow groundwater or which are located close to surface water often have engineering problems with drainage. Generally the water is removed by pumping while the quarry is operational, but for high inflows more complex approaches may be required. For example, the Coquina quarry is excavated to more than 60 feet (18 m) below sea level.

To reduce surface leakage, a moat lined with clay was constructed around the entire quarry. Groundwater entering the pit is pumped up into the moat. As a quarry becomes deeper, water inflows generally increase and it also becomes more expensive to lift the water higher during removal; this can become the limiting factor in quarry depth. Some water-filled quarries are worked from beneath the water, by dredging.

Many people and municipalities consider quarries to be eyesores and require various abatement methods to address problems with noise, dust, and appearance. One of the more effective and famous examples of successful quarry restoration is Butchart Gardens in Victoria, British Columbia, Canada.[4]

A further problem is pollution of roads from trucks leaving the quarries. To control and restrain the pollution of public roads, wheel washing systems are becoming more common.

Many quarries naturally fill with water after abandonment and become lakes. Others are made into landfills.

Water-filled quarries can be very deep, often 50 ft (15 m) or more, and surprisingly cold, so swimming in quarry lakes is generally not recommended. Unexpectedly cold water can cause a swimmer's muscles to suddenly weaken; it can also cause shock and even hypothermia.[5] Though quarry water is often very clear, submerged quarry stones, abandoned equipment, dead animals and strong currents make diving into these quarries extremely dangerous. Several people drown in quarries each year.[6][7] However, many inactive quarries are converted into safe swimming sites.[8][9]

Such lakes, even lakes within active quarries, can provide important habitat for animals.[10]

Health Hazards of Mining and Quarrying

The principal airborne hazards in the mining industry include several types of particulates, naturally occurring gases, engine exhaust and some chemical vapours; the principal physical hazards are noise, segmental vibration, heat, changes in barometric pressure and ionizing radiation. These occur in varying combinations depending on the mine or quarry, its depth, the composition of the ore and surrounding rock, and the method(s) of mining. Among some groups of miners who live together in isolated locations, there is also risk of transmitting some infectious diseases such as tuberculosis, hepatitis (B and E), and the human-immunodeficiency virus (HIV). Miners' exposure varies with the job, its proximity to the source of hazards and the effectiveness of hazard control methods.

Airborne Particulate Hazards

Free crystalline silica is the most abundant compound in the earth's crust and, consequently, is the most common airborne dust that miners and quarry-workers face. Free silica is silicon dioxide that is not chemically bonded with any other compound as a silicate. The most common form of silica is quartz although it can also appear as trydimite or christobalite. Respirable particles are formed whenever silica-bearing rock is drilled, blasted, crushed or otherwise pulverized into fine particles. The amount of silica in different species of rock varies but is not a reliable indicator of how much respirable silica dust may be found in an air sample. It is not uncommon, for example, to find 30% free silica in a rock but 10% in an air sample, and vice versa. Sandstone can be up to 100% silica, granite up to 40%, slate, 30%, with lesser proportions in other minerals. Exposure can occur in any mining operation, surface or underground, where silica is found in the overburden of a surface mine or the ceiling, floor or ore deposit of an underground mine. Silica can be dispersed by the wind, by vehicular traffic or by earth-moving machinery.

With sufficient exposure, silica can cause silicosis, a typical pneumoconiosis that develops insidiously after years of exposure. Exceptionally high exposure can cause acute or accelerated silicosis within months with significant impairment or death occurring within a few years. Exposure to silica is also associated with an increased risk of tuberculosis, lung cancer and of some autoimmune diseases, including scleroderma, systemic lupus erythematosus and rheumatoid arthritis. Freshly fractured silica dust appears to be more reactive and more hazardous than old or stale dust. This may be a consequence of a relatively higher surface charge on freshly formed particles.

The most common processes that produce respirable silica dust in mining and quarrying are drilling, blasting and cutting silica-containing rock. Most holes drilled for blasting are done with an air powered percussion drill mounted on a tractor crawler. The hole is made with a combination of rotation, impact and thrust of the drill bit. As the hole deepens, steel drill rods are added to connect the drill bit to the power source. Air not only powers the drilling, it also blows the chips and dust out of the hole which, if uncontrolled, injects large amounts of dust into the environment. The hand-held jack-hammer or sinker drill operates on the same principle but on a smaller scale. This device conveys a significant amount of vibration to the operator and with it, the risk of vibration white finger. Vibration white finger has been found among miners in India, Japan, Canada and elsewhere. The track drill and the jack-hammer are also used in construction projects where rock must be drilled or broken to make a highway, to break rock for a foundation, for road repair work and other purposes.

Dust controls for these drills have been developed and are effective. A water mist, sometimes with a detergent, is injected into the blow air which helps the dust particles to coalesce and drop out. Too much water results in a bridge or collar forming between the drill steel and the side of the hole. These often have to be broken in order to remove the bit; too little water is ineffective. Problems with this type of control include reduction in the drilling rate, lack of reliable water supply and displacement of oil resulting in increased wear on lubricated parts.

The other type of dust control on drills is a type of local exhaust ventilation. Reverse air-flow through the drill steel withdraws some of the dust and a collar around the drill bit with ductwork and a fan to remove the dust. These perform better than the wet systems described above: drill bits last longer and the drilling rate is higher. However, these methods are more expensive and require more maintenance.

Other controls that provide protection are cabs with filtered and possibly air-conditioned air supply for drill operators, bulldozer operators and vehicle drivers. The appropriate respirator, correctly fitted, may be used for worker protection as a temporary solution or if all others prove to be ineffective.[7,8,9]

Silica exposure also occurs at stone quarries that must cut the stone to specified dimensions. The most common contemporary method of cutting stone is with the use of a channel burner fuelled by diesel fuel and compressed air. This results in some silica particulate. The most significant problem with channel burners is the noise: when the burner is first ignited and when it emerges from a cut, sound level can exceed 120 dBA. Even when it is immersed in a cut, noise is around 115 dBA. An alternative method of cutting stone is to use very high-pressure water.

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Often attached to or nearby a stone quarry is a mill where pieces are sculpted into a more finished product. Unless there is very good local exhaust ventilation, exposure to silica can be high because vibrating and rotating hand tools are used to shape the stone into the desired form.

Respirable coal mine dust is a hazard in underground and surface coal mines and in coal-processing facilities. It is a mixed dust, consisting mostly of coal, but can also include silica, clay, limestone and other mineral dusts. The composition of coal mine dust varies with the coal seam, the composition of the surrounding strata and mining methods. Coal mine dust is generated by blasting, drilling, cutting and transporting coal.

More dust is generated with mechanized mining than with manual methods, and some methods of mechanized mining produce more dust than others. Cutting machines that remove coal with rotating drums studded with picks are the principal sources of dust in mechanized mining operations. These include so-called continuous miners and longwall mining machines. Longwall mining machines usually produce larger amounts of dust than do other methods of mining. Dust dispersion can also occur with the movement of shields in longwall mining and with the transfer of coal from a vehicle or conveyor belt to some other means of transport.

Coal mine dust causes coal workers' pneumoconiosis (CWP) and contributes to the occurrence of chronic airways disease such as chronic bronchitis and emphysema. Coal of high rank (e.g., high carbon content such as anthracite) is associated with a higher risk of CWP. There are some rheumatoid-like reactions to coal mine dust as well.

The generation of coal mine dust can be reduced by changes in coal cutting techniques and its dispersion can be controlled with the use of adequate ventilation and water sprays. If the speed of rotation of cutting drums is reduced and the tram speed (the speed with which the drum advances into the coal seam) is increased, dust generation can be reduced without losses in productivity. In longwall mining, dust generation can be reduced by cutting coal in one pass (rather than two) across the face and tramming back without cutting or by a clean-up cut. Dust dispersion on longwall sections can be reduced with homotropal mining (i.e., the chain-conveyor at the face, the cutter head and the air all travelling in the same direction). A novel method of cutting coal, using an eccentric cutter head that continuously cuts perpendicular to the grain of a deposit, seems to generate less dust than the conventional circular cutting head.

Adequate mechanical ventilation flowing first over a mining crew and then to and across the mining face can reduce exposure. Auxiliary local ventilation at the working face, using a fan with ductwork and scrubber, can also reduce exposure by providing local exhaust ventilation.

Water sprays, strategically placed close to the cutterhead and forcing dust away from the miner and towards the face, also assist in reducing exposure. Surfactants provide some benefit in reducing the concentration of coal dust.

Asbestos exposure occurs among asbestos miners and in other mines where asbestos is found in the ore. Among miners throughout the world, exposure to asbestos has elevated the risk of lung cancer and of mesothelioma. It has also elevated the risk of asbestosis (another pneumoconiosis) and of airways disease.

Diesel engine exhaust is a complex mixture of gases, vapours and particulate matter. The most hazardous gases are carbon monoxide, nitrogen oxide, nitrogen dioxide and sulphur dioxide. There are many volatile organic compounds (VOCs), such as aldehydes and unburned hydrocarbons, polycyclic aromatic hydrocarbons (PAHs) and nitro-PAH compounds (N-PAHs). PAH and N-PAH compounds are also adsorbed onto diesel particulate matter. Nitrogen oxides, sulphur dioxide and aldehydes are all acute respiratory irritants. Many of the PAH and N-PAH compounds are carcinogenic.

Diesel particulate matter consists of small diameter (1 mm in diameter) carbon particles that are condensed from the exhaust fume and often aggregate in air in clumps or strings. These particles are all respirable. Diesel particulate matter and other particles of similar size are carcinogenic in laboratory animals and appear to increase the risk of lung cancer in exposed workers at concentrations above about 0.1 mg/m^3. Miners in underground mines experience exposure to diesel particulate matter at significantly higher levels. The International Agency for Research on Cancer (IARC) considers diesel particulate matter to be a probable carcinogen.

The generation of diesel exhaust can be reduced by engine design and with high-quality, clean and low-sulphur fuel. De-rated engines and fuel with a low cetane number and low sulphur content produce less particulate matter. Use of low sulphur fuel reduces the generation of SO_2 and of particulate matter. Filters are effective and feasible and can remove more than 90% of diesel particulate matter from the exhaust stream. Filters are available for engines without scrubbers and for engines with either water or dry scrubbers. Carbon monoxide can be significantly reduced with a catalytic

converter. Nitrogen oxides form whenever nitrogen and oxygen are under conditions of high pressure and temperature (i.e., inside the diesel cylinder) and, consequently, they are more difficult to eliminate.
The concentration of dispersed diesel particulate matter can be reduced in an underground mine by adequate mechanical ventilation and restrictions on the use of diesel equipment. Any diesel powered vehicle or other machine will require a minimum amount of ventilation to dilute and remove the exhaust products. The amount of ventilation depends on the size of the engine and its uses. If more than one diesel powered piece of equipment is operating in one air course, ventilation will have to be increased to dilute and remove the exhaust.

Diesel powered equipment may increase the risk of fire or explosion since it emits a hot exhaust, with flame and sparks, and its high surface temperatures may ignite any accumulated coal dust or other combustible material. Surface temperature of diesel engines have to be kept below 305 °F (150 °C) in coal mines in order to prevent the combustion of coal. Flame and sparks from the exhaust can be controlled by a scrubber to prevent ignition of coal dust and of methane.

Gases and Vapours

The gases commonly found in mines. The most important naturally occurring gases are methane and hydrogen sulphide in coal mines and radon in uranium and other mines. Oxygen deficiency is possible in either. Methane is combustible. Most coal mine explosions result from ignitions of methane and are often followed by more violent explosions caused by coal dust that has been suspended by the shock of the original explosion. Throughout the history of coal mining, fires and explosions have been the principal cause of death of thousands of miners. Risk of explosion can be reduced by diluting methane to below its lower explosive limit and by prohibiting potential ignition sources in the face areas, where the concentration is usually the highest. Dusting the mine ribs (wall), floor and ceiling with incombustible limestone (or other silica-free incombustible rock dust) helps to prevent dust explosions; if dust suspended by the shock of a methane explosion is not combustible, a secondary explosion will not occur.

Table 1. Common names and health effects of hazardous gases occurring in coal mines

Gas	Common name	Health effects
Methane (CH_4)	Fire damp	Flammable, explosive; simple asphyxiation
Carbon monoxide (CO)	White damp	Chemical asphyxiation
Hydrogen sulphide (H_2S)	Stink damp	Eye, nose, throat irritation; acute respiratory depression
Oxygen deficiency	Black damp	Anoxia
Blasting by-products	After damp	Respiratory irritants
Diesel engine exhaust	Same	Respiratory irritant; lung cancer

Radon is a naturally occurring radioactive gas that has been found in uranium mines, tin mines and some other mines. It has not been found in coal mines. The primary hazard associated with radon is its being a source of ionizing radiation, which is discussed below.

Other gaseous hazards include respiratory irritants found in diesel engine exhaust and blasting by-products. Carbon monoxide is found not only in engine exhaust but also as a result of mine fires. During mine fires, CO can reach not only lethal concentrations but also can become an explosion hazard.

Nitrogen oxides (NO_x), primarily NO and NO_2, are formed by diesel engines and as a by-product of blasting. In engines, NO_x are formed as an inherent by-product of putting air, 79% of which is nitrogen and 20% of which is oxygen, under conditions of high temperature and pressure, the very conditions necessary to the functioning of a diesel engine. The production of NO_x can be reduced to some extent by keeping the engine as cool as possible and by increasing ventilation to dilute and remove the exhaust.

NO_x is also a blasting by-product. During blasting, miners are removed from an area where blasting will occur. The conventional practice to avoid excessive exposure to nitrogen oxides, dust and other results of blasting is to wait until mine ventilation removes a sufficient amount of blasting by-products from the mine before re-entering the area in an intake airway.
Oxygen deficiency can occur in many ways. Oxygen can be displaced by some other gas, such as methane, or it may be consumed either by combustion or by microbes in an air space with no ventilation.

There is a variety of other airborne hazards to which particular groups of miners are exposed. Exposure to mercury vapour, and thus risk of mercury poisoning, is a hazard among gold miners and millers and among mercury miners. Exposure to arsenic, and risk of lung cancer, occurs among gold miners and lead miners. Exposure to nickel, and thus to risk of lung cancer and skin allergies, occurs among nickel miners.

Some plastics are finding use in mines also. These include urea-formaldehyde and polyurethane foams, both of which are plastics made in-place. They are used to plug up holes and improve ventilation and to provide a better anchor for roof supports. Formaldehyde and isocyanates, two starting materials for these two foams, are respiratory irritants and both can cause allergic sensitization making it nearly impossible for sensitized miners to work around either ingredient. Formaldehyde is a human carcinogen [8,9,10]

IV.CONCLUSION

Physical Hazards

Noise is ubiquitous in mining. It is generated by powerful machines, fans, blasting and transportation of the ore. The underground mine usually has limited space and thus creates a reverberant field. Noise exposure is greater than if the same sources were in a more open environment.

Exposure to noise can be reduced by using conventional means of noise control on mining machinery. Transmissions can be quieted, engines can be muffled better, and hydraulic machinery can be quieted as well. Chutes can be insulated or lined with sound-absorbing materials. Hearing protectors combined with regular audiometric testing is often necessary to preserve miners' hearing.

Ionizing radiation is a hazard in the mining industry. Radon can be liberated from stone while it is loosened by blasting, but it may also enter a mine through underground streams. It is a gas and therefore it is airborne. Radon and its decay products emit ionizing radiation, some of which have enough energy to produce cancer cells in the lung. As a result, death rates from lung cancer among uranium miners are elevated. For miners who smoke, the death rate is very much higher.

Heat is a hazard for both underground and surface miners. In underground mines, the principal source of heat is from the rock itself. The temperature of the rock goes up about 1 °C for every 100 m in depth. Other sources of heat stress include the amount of physical activity workers are doing, the amount of air circulated, the ambient air temperature and humidity and the heat generated by mining equipment, principally diesel powered equipment. Very deep mines (deeper than 1,000 m) can pose significant heat problems, with the temperature of mine ribs about 40 °C. For surface workers, physical activity, the proximity to hot engines, air temperature, humidity and sunlight are the principal sources of heat.

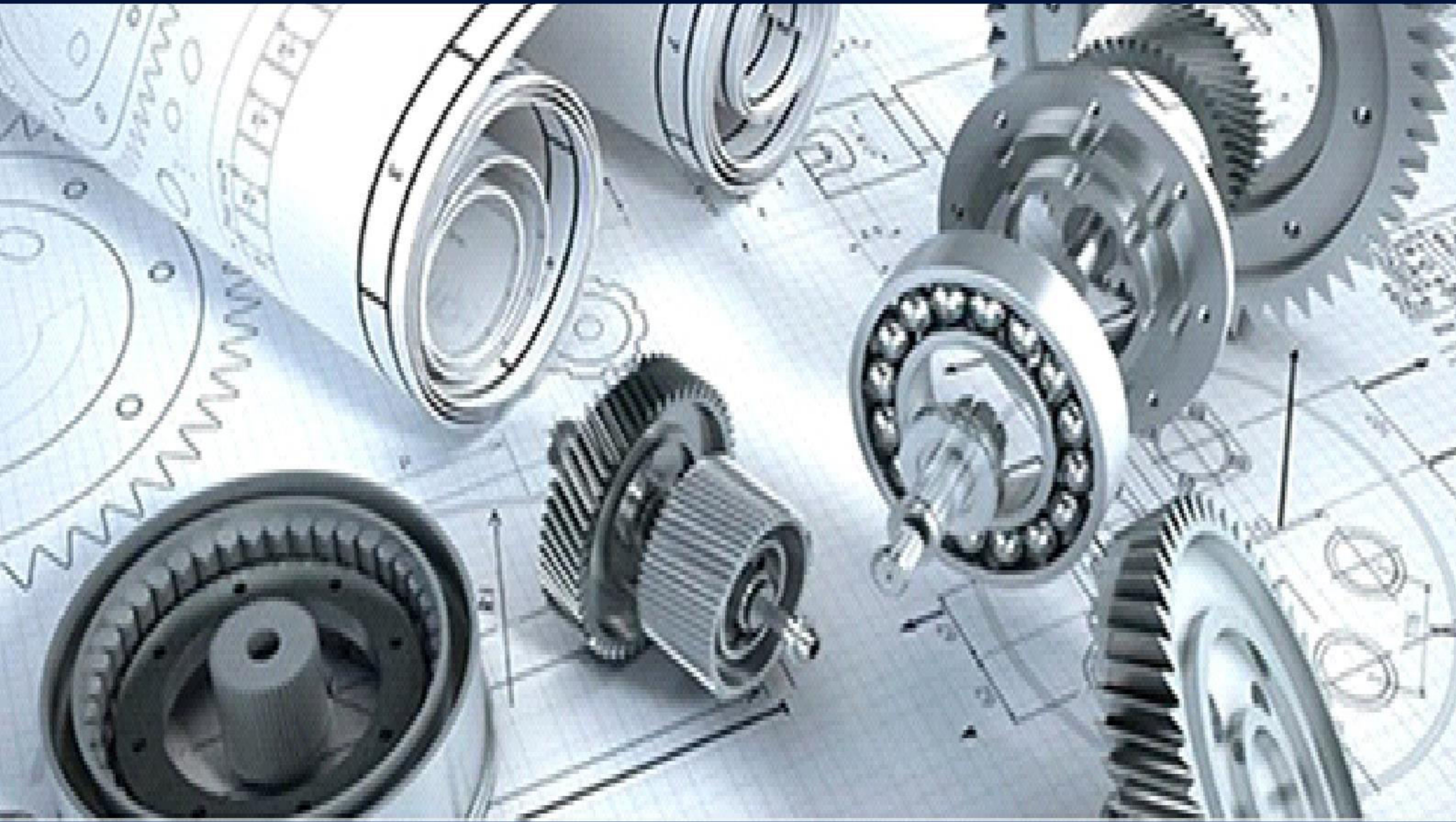
Reduction of heat stress can be accomplished by cooling high temperature machinery, limiting physical activity and providing adequate amounts of potable water, shelter from the sun and adequate ventilation. For surface machinery, air-conditioned cabs can protect the equipment operator. At deep mines in South Africa, for example, underground air-conditioning units are used to provide some relief, and first aid supplies are available to deal with heat stress.

Many mines operate at high altitudes (e.g., greater than 4,600 m), and because of this, miners may experience altitude sickness. This can be aggravated if they travel back and forth between a mine at a high altitude and a more normal atmospheric pressure.[10]

REFERENCES

1. "Law Document English View". Ontario.ca. 2014-07-24. Retrieved 2020-06-30.
2. ^ US EPA, OW (2014-03-10). "Mineral Mining and Processing Effluent Guidelines". US EPA. Retrieved 2020-06-30.
3. ^ Raymond Perrier: Les roches ornementales. Ternay (Edition Pro Roc) 2004, ISBN 2-9508992-6-9, p. 443–447.

4. ^ "BCMEMPR, BCMTH, and NRC. (1995). Reclamation and Environmental Protection Handbook for Sand, Gravel and Quarry Operations in British Columbia. British Columbia Ministry of Energy Mines and Petroleum Resources Ministry of Transportation and Highways Natural Resources Canada" (PDF).
5. ^ "American Canoe Association explanation of cold shock". Enter.net. Archived from the original on 2012-06-16. Retrieved 2012-05-14.
6. ^ "US Dept. of Labor list of mine related fatalities". Msha.gov. Archived from the original on 2012-03-09. Retrieved 2012-05-14.
7. ^ "on quarry drownings". Geology.com. 2007-11-03. Retrieved 2012-05-14.
8. ^ "Centennial Beach - History". www.centennialbeach.org. Retrieved 8 April 2020.
9. ^ "City of Coral Gables - Venetian Pool". www.coralgables.com. Retrieved 8 April 2020.
10. ^ Sievers, Michael (19 May 2017). "Sand quarry wetlands provide high-quality habitat for native amphibians". Web Ecology. 17 (1): 19–27. doi:10.5194/we-17-19-2017. hdl:10072/411143.



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